



## **Fall Creek and Pleasant Run TMDL**

### **Technical Memorandum No. 2A (Final)**

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*Date: June 5, 2003*

*Subject: Fall Creek and Pleasant Run TMDL*  
*Source Assessment and Load Characterization*

#### **Introduction**

The State of Indiana assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Indiana's 305(b) list as required by that section of the CWA that defines the assessment process, and are published every two years.

Some of the 305(b) partially and not supporting water bodies are also assigned to Indiana's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

*E. coli* bacteria data were collected from the Fall Creek and Pleasant Creek in Marion County. Data collected by Indiana Department of Environmental Management (IDEM) indicate that the *E. coli* bacteria standard is exceeded on the following locations:

- Fall Creek: Emerson Avenue to confluence with West Fork White River
- Pleasant Run: Entire length

As a result, these two water bodies were added to the State's 1998 303(d) list and scheduled for a TMDL evaluation.

## Water Quality Assessment

Previous issued technical memorandums (TM 1A, 1B and 1C) document the existing water quality for Fall Creek and Pleasant Run. The findings of the previous memos indicate that the *E. coli* bacteria standard of 125 cfu per 100 ml (geometric mean of 30 days) and 235 cfu per 100 ml (maximum day value) are often exceeded on Fall Creek and Pleasant Run. **Tables 1** and **2** present summary findings of the *E. coli* bacteria counts in Fall Creek and Pleasant Run, respectively from TM 1C.

## Source Assessment and Load Characterization

A source assessment is used to characterize the known and suspected sources of *E. coli* bacteria in the watershed for use in the water quality model, and the development of the TMDL. There are no NPDES wastewater treatment facilities on Fall Creek and one on Pleasant Run, which is for cooling water, and which has no *E. coli* bacteria.

The *E. coli* bacteria for this TMDL was characterized for the following sources:

- Septic systems
- Illicit connections to storm drains
- Wildlife/Natural
- Stormwater runoff
- Combined sewer overflows

All sources of *E. coli* bacteria identified in the two watersheds are assigned a loading rate based on data from the City of Indianapolis, literature values and population in the watershed. Because of varying decay or die-off rates for *E. coli* bacteria, and varying transport assumptions, the *E. coli* bacteria loading from these sources are computed separately in the model as described in the following sections.

### Failing Septic Systems

Failing septic systems have been linked to increased *E. coli* bacteria levels in streams throughout the world. In accordance with the City of Indianapolis' Barrett Law program, a list of neighborhoods with failing septic systems is kept and updated based on new information. Scheduling of sewer projects in each neighborhood is partially based on the degree of system failure that is observed. The failure information has been obtained for the period of 2000 through 2002 and was compared to sampling data for that same period. As of early 2000, there were 13 priority-1 septic neighborhoods within the Fall Creek, Pleasant Run, and Mud Creek watershed boundaries, as well as four priority-2 and three priority-3 septic neighborhoods. The number of septic systems in each watershed was estimated based on IMAGIS (Indianapolis Mapping and Geographic Infrastructure System) coverages for septic

neighborhoods, buildings, and watersheds. *E. coli* bacteria loads were estimated based on an assumed failure rate, flow rate, and *E. coli* counts for the septic neighborhoods. For purposes of the TMDL analysis, the failure rate for a septic system is related to the priority of the area as follows:

- Priority 1: 25% failure rate
- Priority 2: 15% failure rate
- Priority 3: 10% failure rate
- All others: 5% failure rate

A flow of 100 gallons/person-day and a concentration of 10,000 cfu per 100 ml (Horsley and Whitten, 1996) to each failing septic system were assigned. Leaking septic systems are included in the water quality model as a point source having constant flow and concentration. The loading rate attributed to leaking septic systems is estimated to be  $4.66 \times 10^{10}$  cfu per day. **Table 3** summarizes the estimated septic *E. coli* loadings into Fall Creek and Pleasant Run.

### **Illicit Discharges to Storm Drains**

Stormwater outfalls often carry *E. coli* during dry weather because of loadings from illicit sanitary connections to the stormwater collection system. The City of Indianapolis Fifth Annual Report (2002) (AMEC, 2003) reported that approximately 7.7% of the stormwater outfalls sampled contained dry weather flows. For each illicit discharge, a flow of 20 gpd with 10,000 cfu per 100 ml for *E. coli* bacteria was assigned. **Table 4** summarizes the estimated illicit storm drain *E. coli* loadings into Fall Creek and Pleasant Run.

### **Wildlife and Natural Background**

Not all *E. coli* in waterways is the result of man-made sources. Wildlife, both instream and on-bank can be a source of *E. coli* Bacteria to the streams. To estimate the potential load from wildlife, the instream monitoring station at 71<sup>st</sup> Street on Fall Creek was utilized. The land use above 71<sup>st</sup> Street indicates natural conditions with few anthropogenic, or human caused, sources. The area above 71<sup>st</sup> Street has a fully developed storm sewer system that contributes to Fall Creek, but this should not contribute a significant amount of *E. coli* bacteria during dry weather flow conditions. The *E. coli* Bacteria monitoring data from this station was used to represent the wildlife or natural *E. coli* Bacteria load into the streams. **Table 5** summarizes the estimated *E. coli* concentrations and loadings into Fall Creek and Pleasant Run that are a result of natural biota in the watersheds.

### **Stormwater Runoff**

Stormwater often carries *E. coli* because of loadings from domestic animals, wildlife, and agricultural land. Information from the City of Indianapolis' stormwater program and GIS coverages provided insight into the contribution of stormwater to the *E. coli* exceedences seen in Fall Creek and Pleasant Run and showed what progress has been made thus far in

alleviating that contribution. Average stormwater *E. coli* counts were estimated from IMAGIS landuse and watershed coverages. These counts were applied to daily surface runoff flows from October 1991 to October 2001 predicted using the City's watershed model (NETSTORM). **Table 6** contains a summary of the average daily surface runoff flows and *E. coli* loadings into Fall Creek and Pleasant Run based on land use. **Table 6B** shows the percentages of stormwater loads into Fall Creek and Pleasant Run that come from permitted (storm drain outfall), non-permitted (surface runoff), and out-of-county sources.

### Combined Sewer Overflows

Combined Sewer Overflows (CSOs) can be a large source of *E. coli* in urban streams. The CSO flows and *E. coli* bacteria loadings were determined in a methodology similar to those presented in the CSO Control Technologies Evaluation (CDM, 2003) document. CSO discharges were predicted by the City's collection system model for a ten year period of time (October 1991 to October 2001). *E. coli* sampling of CSO discharges were performed by the City in 2001 to characterize CSO discharges. Concentrations ranged from 500,000 cfu per 100 ml up to 900,000 cfu per 100 ml. The CSO flows and *E. coli* loads were predicted using the City's model and sampling data. **Table 7** contains a summary of the estimated *E. coli* loadings from CSOs on Fall Creek and Pleasant Run.

### Description of Daily *E. coli* Bacteria Model

A comprehensive model of each stream (Fall Creek and Pleasant Run) was developed and validated to the existing instream *E. coli* bacteria data. The model simulated the daily instream bacteria counts for each stream segment based on loads from the sources described above. For the dry weather sources, a constant load was applied, whereas for stormwater runoff and CSO discharges, the *E. coli* bacteria load was based on the City's watershed model (for stormwater) and collection system model (for CSO discharges). A ten year period of time (October 1991 through September 2001) was simulated. Data on stream flow was used to predict the resultant instream *E. coli* bacteria counts for each day for the ten year period.

Daily flow data for the Fall Creek – Millersville station and the Pleasant Run – Arlington Avenue station was obtained from the USGS for the period of October 1, 1991 through September 30, 2001. Daily flow data was used for the daily *E. coli* bacteria model

**Table 8** presents a sample page from the daily *E. coli* bacteria model for the Fall Creek – the CSO area. **Figure 1** presents the predicted instream bacteria counts for April 1, 1997 to October 31, 1997.

Model calibration consisted of comparisons of the geometric mean, percent of samples over 235 cfu/100 ml and the number of samples over 10,000 cfu/100 ml per year of sampling. These comparisons were performed for both dry-weather and wet-weather data. The calibration of the mass balance model for *E. coli* bacteria included QAQC of the USGS daily

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flow data, adjustment for *E. coli* contributions from wildlife for all reaches, adjustment for the Pleasant Run septic flow *E. coli* contributions, and for *E. coli* contributions from stormwater. **Table 9** contains a summary of the observed and modeled *E. coli* bacteria loading parameters for the four watersheds modeled. **Table 10** summarizes the daily septic, illicit, wildlife, stormwater, and CSO *E. coli* bacteria loadings into Fall Creek, Pleasant Run, and Mud Creek.

## Next Step

The next step in the TMDL process is to examine *E. coli* bacteria load reduction scenarios to determine attainment of water quality standards.

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**Table 1: *E. coli* Bacteria Compliance – Fall Creek**

River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
Fall Creek - Upstream of CSO Area	117	27.4%	0	274
Fall Creek - Within CSO Area	295	50.1%	20	902
Mud Creek - Tributary to Fall Creek	125	16.0%	1	144
Devon Creek - Tributary to Fall Creek	347	59.2%	0	49
Lawrence Creek - Tributary to Fall Creek	132	17.2%	0	29

**Dry Weather**

River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
Fall Creek - Upstream of CSO Area	72	11.4%	0	132
Fall Creek - Within CSO Area	146	33.2%	0	425
Mud Creek - Tributary to Fall Creek	89	6.8%	0	73
Devon Creek - Tributary to Fall Creek	259	58.3%	0	24
Lawrence Creek - Tributary to Fall Creek	112	14.3%	0	14

**Wet Weather**

River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
Fall Creek - Upstream of CSO Area	185	42.3%	0	142
Fall Creek - Within CSO Area	552	65.2%	20	477
Mud Creek - Tributary to Fall Creek	176	25.4%	1	71
Devon Creek - Tributary to Fall Creek	460	60.0%	0	25
Lawrence Creek - Tributary to Fall Creek	155	20.0%	0	15

**State Guidance <sup>(1)</sup>**

**(IDEM standard of 125 cfu/100 ml)**

**(IDEM Guidance 10% or less)**

**(IDEM Guidance None > 10,000 cfu/100 ml)**

<sup>(1)</sup> Indiana's 303(d) Listing Methodology for Impaired Waterbodies and Total Maximum Daily Load - September 2002

<sup>(2)</sup> Samples over 10,000 cfu/100 ml are normalized for the 1.5 year sampling period

**Table 2: *E. coli* Bacteria Compliance – Pleasant Run**

**All Data**

River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
Pleasant Run - Upstream of CSO Area	342	59.3%	3	258
Pleasant Run - Within CSO Area	413	59.5%	19	862
<del>Bean Creek - Upstream of CSO Area</del>	<del>502</del>	<del>71.1%</del>	<del>4</del>	<del>340</del>
Bean Creek - Within CSO Area	466	71.3%	3	178

**Dry Weather**

River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
Pleasant Run - Upstream of CSO Area	267	56.2%	0	137
Pleasant Run - Within CSO Area	269	53.8%	2	461
Bean Creek - Upstream of CSO Area	421	68.6%	1	175
Bean Creek - Within CSO Area	346	70.5%	0	88

**Wet Weather**

River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
Pleasant Run - Upstream of CSO Area	454	62.8%	3	121
Pleasant Run - Within CSO Area	676	66.1%	17	401
Bean Creek - Upstream of CSO Area	603	73.3%	3	165
Bean Creek - Within CSO Area	625	72.2%	3	90

State Guidance <sup>(1)</sup>

(IDEM standard of 125 cfu/100 ml)

(IDEM Guidance 10% or less)

(IDEM Guidance None > 10,000 cfu/100 ml)

<sup>(1)</sup> Indiana's 303(d) Listing Methodology for Impaired Waterbodies and Total Maximum Daily Load - September 2002

<sup>(2)</sup> Samples over 10,000 cfu/100 ml are normalized for the 1.5 year sampling period

**TABLE 3: FAILING SEPTIC SYSTEMS  
FALL CREEK & PLEASANT RUN**

Watershed	Approximate Count of Septic Systems				Total Septic Systems	Estimated Failing Septic Systems	Approximate Population	Estimated Failing Septic Flow (MGD)	Estimated Failing Septic Daily Load (cfu)	Estimated Failing Septic Monthly Load (cfu)
	Barrett Law Priority 1	Barrett Law Priority 2	Barrett Law Priority 3	Non-Barrett Law						
<b>Assumed Failure Rate</b>	<b>25%</b>	<b>15%</b>	<b>10%</b>	<b>5%</b>						
Mud Creek	113	0	0	55	168	31	109	0.01	4.11E+09	1.23E+11
Fall Creek Upstream	899	465	179	165	1708	321	1122	0.11	4.25E+10	1.27E+12
Fall Creek CSO	0	0	0	0	0	0	0	0.00	0.00E+00	0.00E+00
<b>Fall Creek Totals</b>	<b>1012</b>	<b>465</b>	<b>179</b>	<b>220</b>	<b>1876</b>	<b>352</b>	<b>1231</b>	<b>0</b>	<b>4.66E+10</b>	<b>1.40E+12</b>
Pleasant Run Upstream	163	204	56	89	512	81	285	0.03	5.39E+09	3.24E+11
Pleasant Run CSO	30	129	0	94	253	32	110	0.01	4.18E+09	1.25E+11
<b>Pleasant Run Totals</b>	<b>193</b>	<b>333</b>	<b>56</b>	<b>183</b>	<b>765</b>	<b>113</b>	<b>395</b>	<b>0</b>	<b>9.57E+09</b>	<b>4.49E+11</b>

\*Assumptions include 3.5 persons per septic system, 100 gpcd septic flow, and 10,000 cfu/100 ml E. coli in the septic flow

\*\*Persons per system and per capita flows taken from May 1989 DPW Design Standards

\*\*\*Assume 5,000 cfu/100 ml for Pleasant Run Upstream



**TABLE 4: ILLICIT CONNECTIONS TO STORM DRAINS  
FALL CREEK & PLEASANT RUN**

Watershed	# of Storm Outfalls	Miles of Storm Sewer and Drains	Approximate number of Illicit Connections	Illicit Flow (MGD)	Estimated Illicit Connection Daily Load (cfu)	Estimated Illicit Connection Monthly Load (cfu)
Mud Creek	58	65	4	8.00E-05	3.03E+07	9.08E+08
Fall Creek Upstream	151	244	12	2.40E-04	9.08E+07	2.73E+09
Fall Creek CSO	93	71	7	1.40E-04	5.30E+07	1.59E+09
Pleasant Run Upstream	85	127	7	1.40E-04	5.30E+07	1.59E+09
Pleasant Run CSO	110	155	8	1.60E-04	6.06E+07	1.82E+09

\*Illicit Connections assumed at 7.7% of outfalls (based on 2002 NPDES Stormwater report sampling data)  
20 gpd sanitary flow, and 10,000 cfu/100 ml E. coli in the illicit flow

**TABLE 5: INSTREAM WILDLIFE  
FALL CREEK & PLEASANT RUN**

Watershed	Average Dry-Weather E. coli (cfu/100 ml)	Average Dry-Weather stream flow (cfs)	Approximate Instream Wildlife Daily Load (cfu)	Estimated Instream Wildlife Monthly Load (cfu)
Fall Creek Upstream	33	23	1.85E+10	5.54E+11
Fall Creek CSO	34	70	5.81E+10	1.74E+12
Pleasant Run Upstream	20	2.0	9.79E+08	2.94E+10
Pleasant Run CSO	20	2.0	9.79E+08	2.94E+10

\*The 71st Street Sampling Station along Fall Creek is not in close proximity to any septic systems.  
Its dry-weather observed E. coli bacteria concentrations are assumed to be the result of wildlife.  
This concentration is applied to all other streams

\*These concentrations were later adjusted to match observed daily data

**TABLE 6: STORMWATER RUNOFF FROM SEPARATE SEWER AREAS  
FALL CREEK & PLEASANT RUN**

	Approximate Percentage of Specified Landuse								Approximate Average E. Coli Concentration (cfu/100 ml)	Daily Average Stormwater Flow (cfs)	Daily Average Stormwater Load (cfu)
Landuse Type	Commercial	Residential	Historic & Hospital	Industrial	Parks	Highway ROW	Spec. Uses	University			
Zoning Class	All C's	All D's	All H's	All I's	All PK's	ROW, RC	All SU's	All U's			
Assumed E. coli concentration	2500	2000	2500	5000	2000	5000	3000	3000			
Fall Creek Upstream	3%	71%	0%	2%	4%	1%	19%	0%	2300	25	1.42E+12
Fall Creek CSO	9%	65%	1%	9%	4%	2%	9%	1%	2300	6	3.40E+11
Pleasant Run Upstream	11%	53%	0%	22%	7%	4%	3%	0%	2200	5	2.56E+11
Pleasant Run CSO	12%	68%	1%	12%	2%	1%	2%	1%	2200	1	4.35E+10

**TABLE 6B: UNPERMITTED AND PERMITTED STORMWATER RUNOFF SOURCES  
FALL CREEK AND PLEASANT RUN**

Watershed	Permitted Storm Sewer Area (Acres)	Area without Storm Sewers (Acres)	Area outside County (Acres)	Total Area (Acres)	% Permitted	% Unpermitted	% Out of County
Fall Creek Upstream*	26,000	-	33,000	59,000	45%	0%	55%
Pleasant Run & Bean Creek Upstream	14,000	-	-	14,000	100%	0%	0%

\*Includes Mud Creek and Indian Creek

**TABLE 7: COMBINED SEWER OVERFLOWS  
FALL CREEK & PLEASANT RUN**

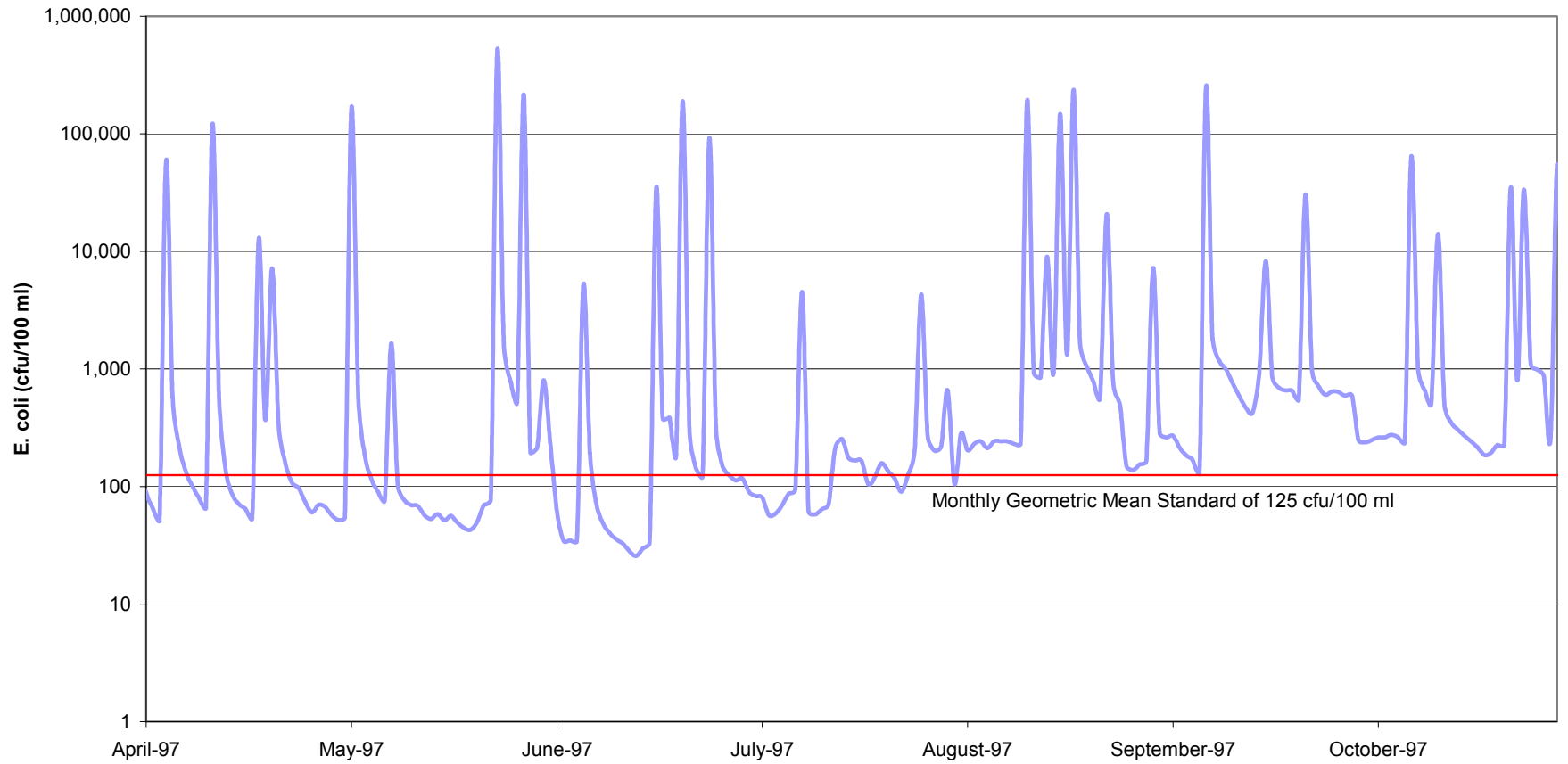
Watershed	# Of CSO Regulators	# of CSO Outfalls	Annual Average CSO Volume (MG)	Average CSO E. Coli Concentration (cfu/100 ml)	Annual Average CSO E. Coli Load (cfu)	Daily Average CSO E. Coli Load (cfu)	Monthly Average CSO E. Coli Load (cfu)
Fall Creek CSO	35	26	1713	9.33E+05	4.02E+16	1.10E+14	3.30E+15
Pleasant Run CSO	51	51	334	1.21E+06	1.51E+16	4.13E+13	1.24E+15

\*Flows and bacteria loadings are from the 50-year rainfall record

TABLE 8: SAMPLE OF FALL CREEK CSO AREA DAILY E. COLI COUNTS

Date	Average Daily Flow (cfs)	Water Company Withdrawl (cfs)	Stormwater Runoff (cfs)	CSO Flow (cfs)	Corrected Average Daily Flow (cfs)	Septic Load (cfu/day)	Illicit Load (cfu/day)	Wildlife Load (cfu/day)	Stormwater Load (cfu/day)	CSO Load (cfu/day)	Total Load (cfu/day)	Resulting Concentration (cfu/100 ml)
10/1/1991	54	24	0	0	30	4.66E+10	1.74E+08	7.76E+10	0.00E+00	0.00E+00	1.24E+11	167
10/2/1991	58	24	0	0	34	4.66E+10	1.74E+08	7.76E+10	0.00E+00	0.00E+00	1.24E+11	148
10/3/1991	68	24	23	2	69	4.66E+10	1.74E+08	7.76E+10	1.27E+12	3.84E+13	3.98E+13	23,649
10/4/1991	57	24	6	0	40	4.66E+10	1.74E+08	7.76E+10	3.57E+11	0.00E+00	4.81E+11	494
10/5/1991	75	24	121	30	203	4.66E+10	1.74E+08	7.76E+10	6.81E+12	6.84E+14	6.91E+14	139,433
10/6/1991	68	24	32	0	77	4.66E+10	1.74E+08	7.76E+10	1.80E+12	0.00E+00	1.93E+12	1,030
10/7/1991	58	24	16	0	51	4.66E+10	1.74E+08	7.76E+10	9.03E+11	0.00E+00	1.03E+12	832
10/8/1991	56	24	9	0	42	4.66E+10	1.74E+08	7.76E+10	5.12E+11	0.00E+00	6.36E+11	626
10/9/1991	55	24	5	0	37	4.66E+10	1.74E+08	7.76E+10	3.06E+11	0.00E+00	4.30E+11	477
10/10/1991	58	24	15	1	50	4.66E+10	1.74E+08	7.76E+10	8.41E+11	1.47E+13	1.57E+13	12,791
10/11/1991	58	24	7	0	41	4.66E+10	1.74E+08	7.76E+10	3.83E+11	0.00E+00	5.08E+11	503
10/12/1991	57	24	4	0	37	4.66E+10	1.74E+08	7.76E+10	2.19E+11	0.00E+00	3.43E+11	376
10/13/1991	56	24	2	0	35	4.66E+10	1.74E+08	7.76E+10	1.36E+11	0.00E+00	2.60E+11	305
10/14/1991	57	24	7	0	41	4.66E+10	1.74E+08	7.76E+10	3.83E+11	5.72E+12	6.23E+12	6,286
10/15/1991	56	24	5	0	37	4.66E+10	1.74E+08	7.76E+10	2.54E+11	0.00E+00	3.78E+11	418
10/16/1991	57	24	2	0	36	4.66E+10	1.74E+08	7.76E+10	1.31E+11	0.00E+00	2.55E+11	292
10/17/1991	56	24	1	0	34	4.66E+10	1.74E+08	7.76E+10	7.71E+10	0.00E+00	2.01E+11	243
10/18/1991	55	24	1	0	32	4.66E+10	1.74E+08	7.76E+10	4.54E+10	0.00E+00	1.70E+11	215
10/19/1991	56	24	2	0	34	4.66E+10	1.74E+08	7.76E+10	1.05E+11	0.00E+00	2.29E+11	273
10/20/1991	56	24	1	0	33	4.66E+10	1.74E+08	7.76E+10	5.23E+10	0.00E+00	1.77E+11	216
10/21/1991	56	24	0	0	33	4.66E+10	1.74E+08	7.76E+10	2.41E+10	0.00E+00	1.48E+11	185
10/22/1991	54	24	0	0	31	4.66E+10	1.74E+08	7.76E+10	9.62E+09	0.00E+00	1.34E+11	179
10/23/1991	55	24	0	0	32	4.66E+10	1.74E+08	7.76E+10	2.74E+09	0.00E+00	1.27E+11	165
10/24/1991	58	24	0	317	352	4.66E+10	1.74E+08	7.76E+10	2.96E+09	7.25E+15	7.25E+15	841,649
10/25/1991	67	24	143	0	186	4.66E+10	1.74E+08	7.76E+10	8.03E+12	0.00E+00	8.16E+12	1,791
10/26/1991	368	24	873	0	1217	4.66E+10	1.74E+08	7.76E+10	4.91E+13	0.00E+00	4.92E+13	1,653
10/27/1991	299	24	330	0	605	4.66E+10	1.74E+08	7.76E+10	1.85E+13	0.00E+00	1.87E+13	1,261
10/28/1991	121	24	77	0	174	4.66E+10	1.74E+08	7.76E+10	4.31E+12	0.00E+00	4.44E+12	1,042
10/29/1991	77	24	31	0	84	4.66E+10	1.74E+08	7.76E+10	1.74E+12	0.00E+00	1.87E+12	905
10/30/1991	64	24	15	1	57	4.66E+10	1.74E+08	7.76E+10	8.58E+11	3.16E+13	3.26E+13	23,362
10/31/1991	57	24	9	0	42	4.66E+10	1.74E+08	7.76E+10	4.79E+11	0.00E+00	6.03E+11	588
11/1/1991	66	30	18	0	55	4.66E+10	1.74E+08	7.76E+10	1.02E+12	0.00E+00	1.15E+12	858
11/2/1991	64	30	12	0	46	4.66E+10	1.74E+08	7.76E+10	6.70E+11	0.00E+00	7.95E+11	701
11/3/1991	55	30	6	0	32	4.66E+10	1.74E+08	7.76E+10	3.45E+11	0.00E+00	4.69E+11	607
11/4/1991	51	30	4	0	26	4.66E+10	1.74E+08	7.76E+10	2.34E+11	0.00E+00	3.58E+11	572
11/5/1991	49	30	3	0	22	4.66E+10	1.74E+08	7.76E+10	1.50E+11	0.00E+00	2.74E+11	507
11/6/1991	46	30	2	0	18	4.66E+10	1.74E+08	7.76E+10	9.33E+10	0.00E+00	2.18E+11	492
11/7/1991	46	30	3	0	19	4.66E+10	1.74E+08	7.76E+10	1.50E+11	0.00E+00	2.74E+11	587
11/8/1991	44	30	2	0	16	4.66E+10	1.74E+08	7.76E+10	9.09E+10	0.00E+00	2.15E+11	548
11/9/1991	44	30	1	0	15	4.66E+10	1.74E+08	7.76E+10	4.76E+10	0.00E+00	1.72E+11	460
11/10/1991	44	30	0	0	15	4.66E+10	1.74E+08	7.76E+10	2.46E+10	0.00E+00	1.49E+11	409
11/11/1991	43	30	0	0	14	4.66E+10	1.74E+08	7.76E+10	1.15E+10	0.00E+00	1.36E+11	407
11/12/1991	43	30	3	0	16	4.66E+10	1.74E+08	7.76E+10	1.46E+11	9.89E+11	1.26E+12	3,201
11/13/1991	43	30	2	0	15	4.66E+10	1.74E+08	7.76E+10	9.67E+10	0.00E+00	2.21E+11	596
11/14/1991	43	30	1	0	14	4.66E+10	1.74E+08	7.76E+10	3.98E+10	0.00E+00	1.64E+11	474
11/15/1991	43	30	2	0	15	4.66E+10	1.74E+08	7.76E+10	9.23E+10	0.00E+00	2.17E+11	587

**Figure 1: Fall Creek CSO Area Daily E. coli Counts**  
**April 1, 1997 through October 31, 1997**



**TABLE 9: COMPARISON OF OBSERVED AND MODELED E. COLI COUNTS  
FALL CREEK AND PLEASANT RUN**

	Geometric Mean			% of Days > 235			# of Samples > 10000 per Year		
Watershed	All	Dry	Wet	All	Dry	Wet	All	Dry	Wet
Fall Creek-Upstream Measured	117	72	185	27%	11%	42%	0	0	0
Fall Creek-Upstream Modeled	139	72	169	37%	12%	41%	0	0	0
Fall Creek-CSO Measured	295	146	552	50%	33%	65%	20	0	20
Fall Creek-CSO Modeled	373	138	487	51%	34%	54%	38	0	38
Pleasant Run-Upstream Measured	342	267	454	59%	56%	63%	3	0	3
Pleasant Run-Upstream Modeled	368	257	443	63%	62%	64%	0	0	0
Pleasant Run-CSO Measured	413	269	676	60%	54%	66%	19	2	17
Pleasant Run-CSO Modeled	448	259	597	60%	62%	58%	24	0	24

\*Measured *E. coli* counts are reported in Tables 1 and 2

**TABLE 10: TOTAL AVERAGE E. COLI DAILY LOAD  
FALL CREEK & PLEASANT RUN**

Watershed	Average Daily Septic Load (cfu)	Average Daily Illicit Connection Load (cfu)	Average Daily Wildlife Load (cfu)	Average Daily Stormwater Load (cfu)	Average Daily CSO Load (cfu)	Total Average Daily Load (cfu)	Total Cumulative Daily Load (cfu)
Mud Creek*	4.11E+09	3.03E+07	9.79E+08	0**	0.00E+00	5.12E+09	
Fall Creek Upstream	4.25E+10	9.08E+07	1.85E+10	1.42E+12	0.00E+00	1.48E+12	1.48E+12
Fall Creek CSO	0.00E+00	5.30E+07	5.81E+10	3.40E+11	1.10E+14	1.11E+14	<b>1.12E+14</b>
Pleasant Run Upstream	5.39E+09	5.30E+07	9.79E+08	2.56E+11	0.00E+00	2.62E+11	
Pleasant Run CSO	4.18E+09	6.06E+07	9.79E+08	4.35E+10	4.13E+13	4.14E+13	<b>4.17E+13</b>

\*Note: Average Daily flow for Mud Creek not currently known, Wildlife load was assumed to be the same as Pleasant Run

\*\*Note: Mud Creek Stormwater Loads are incorporated into Fall Creek